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TOTAL SOLAR ECLIPSE

JANUARY 1898

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THE

TOTAL SOLAR ECLIPSE

OF

JANUARY. 1898.

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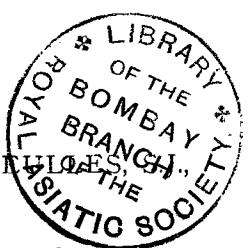

BY

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AND

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THE TOTAL SOLAR ECLIPSE.

ON the 22nd January will occur in India perhaps the most interesting of all astronomical phenomena: a total eclipse of the Sun. Eclipses, both lunar and solar, are not, absolutely speaking, exceptionally rare phenomena, as in a cycle of a little more than 18 years, after which they recur in the same order and approximately the same circumstances, they number about 70, 41 of them being solar and 29 lunar eclipses. The recurrence only refers to the Globe as a whole; but a given locality, for reasons explained later on, has scarcely, on an average, a solar eclipse once in two years, and a total one in two centuries. This lends a special interest to the one, parts of the Bengal and Bombay Presidencies and of the Central Provinces will witness next month, as none of their inhabitants are likely to observe another, unless they migrate to some other country. Under these circumstances a few words on the subject may prove interesting.

A solar eclipse is produced, whenever the opaque body of the Moon comes and places itself between the observer's eye and the Sun, either partly or entirely intercepting its rays. Let us see how this may happen. The Sun's diameter being much larger than that of the Moon, common exterior or direct tangents, drawn to the two discs, will necessarily meet in space on the side of our satellite opposite to the Sun, while interior or transverse ones will intersect between the two luminaries and go on

diverging behind the Moon. A little reflexion will show that no solar ray can reach any spot situated in the cone limited by the exterior tangents, while those located behind the Moon, in the diverging cone of the interior tangents, receive light only from a portion of the solar disc. The first cone, that of perfect shadow, is known under the name of Umbra, and that of partial illumination under the name of Penumbra. In its revolution round the Earth, the Moon carries these two cones through space, and, whenever the apex of the Umbra reaches or over-reaches any part of our Planet, that locality for a time ceases to receive any of the Sun's rays and witnesses a total solar eclipse. If, however, a region enters more or less deeply, in the diverging Penumbra cone only, then only part of the solar rays are intercepted, and for such a place the eclipse is merely partial. We shall speak later on of annular eclipses.

Were the orbits of the Moon and Earth in the same plane, and were the relative distances of the Sun, Moon, and Earth constant, there would be two total eclipses every lunar month: a total eclipse of the Moon, when the Moon is in opposition, and a total or annular eclipse of the Sun, when the Moon is in conjunction. (The Moon is said to be in conjunction when the centres of the Sun, Moon, and Earth are in the same plane perpendicular to that of the Ecliptic, the plane of the orbit of the Earth, in the order, S. M. E.; and in opposition, when, under the same circumstances, the order is S. E. M.) But such is not the case; the lunar orbit is inclined at an angle of $5^\circ\ 9'$ on the plane of the Ecliptic. This causes our satellite to be frequently either above or below that plane when in conjunction or in opposition. As a consequence, the number of possible eclipses is considerably reduced. To produce a total solar eclipse, the Moon must be in conjunction at the time it crosses the Ecliptic, so that the

Umbra cone may meet the Earth. When this is nearly the case, and we are only more or less deeply immerged in the broader cone of Penumbra, a more or less extensive partial eclipse takes place. The same can be said, *mutatis mutandis*, for lunar eclipses, when the Moon is in opposition. As things stand, the maximum number of possible eclipses in a year is seven, and the minimum two; as a mean, four. All these, however, are not always visible at a given place; for both the Sun and the Moon may be under the horizon at the time, and moreover, in the case of solar eclipses, the tracks covered by both the lunar Umbra and Penumbra are always rather narrow.

The variations of relative distances between the Sun, the Moon, and the Earth have been mentioned as influencing eclipses. These distances, as is well known, vary considerably. The greatest and the smallest distances between the Earth and the Sun are respectively called Aphelion and Perihelion; those between the Earth and the Moon, Apogee and Perigee. Now the nearer the Moon is to its Perigee at the time of a total solar eclipse, the deeper evidently will the Earth truncate the Umbra cone, the broader will be the Umbra's path over our Planet, and wider consequently the band-like zone within which a total eclipse will be visible. Let the Earth be at the same time at Aphelion. The nearer approach of the Moon increases for us its apparent diameter, so that it hides from our sight a greater extent of the sky; while, on account of its greater distance, the Sun's apparent diameter is diminished. The result is an eclipse of longer duration. If, on the other hand, we have the Earth nearing its Perihelion, when the Moon is at its Apogee, the cone of shadow does not even reach us. In other words, the diminished disc of the Moon is no longer large enough to cover entirely the increased disc of the Sun; a luminous ring is

left round the Moon, and the eclipse is annular. The time an eclipse, either total or otherwise, will occupy, depends consequently on the relative distances between, the Sun, the Moon and the Earth.

Altogether an eclipse cannot last over six hours, from the time of first to that of last exterior contact of the discs, and it is generally of a much shorter duration. The maximum duration of the total phase is 6m. 50s. at the Equator (1) and decreases with the latitude of the locality. The conditions of maximum, the most favourable for observations, are of course of very rare occurrence and will not be realized on January the 22nd.

On this day, the shadow first touches the Earth in the Congo State, in Longitude 21° 36′ E. and Latitude 0° 28′ N.; this first contact occurs at 10h. 39·4m. A.M., Calcutta time. The total eclipse begins at sunrise, in the west of the Soudan, in Long. 9° 46′ E. and Lat. 11° 14′ N. (11h. 42·2m. A.M., Calcutta time). From this point, the cone of shadow advances first in an E. S. E. direction, then turns towards the east, and travels parallel to the Equator until it crosses the southern part of the coast of Somali. Changing then its course to N. E., the shadow sweeps across the Indian Ocean, and strikes the coast of India below Bombay, as shown on the map. After having traversed the greater part of India, the path of totality lies across Thibet and China, terminating in the west of Manchuria, at sunset, in Long. 119° 9′ E. and Lat. 45° 47′ N. (2h. 43·1m. P.M., Calcutta time). The last contact of the shadow with the Earth takes place in China, in Long. 110° 7′ E. and Lat. 35° 36′ N. at 3h. 45·9m., Calcutta time. Some idea of the rapidity with which the eclipse will travel on the surface of the Earth may be obtained from the preceding figures: starting at 11h. 42m. A.M., from

[1] Eclipse totale du Soleil du 16 Avril 1893, par Deslandres, p. 4.

the west of Africa, it reaches China at 2h. 43m. P.M.; the whole journey takes only 3 hours!

Let us now, with the help of the map, examine more in detail the part of this journey performed in India. The three parallel lines show the path of totality; the middle one is called the central line: an observer situated anywhere along this line will see the centre of the Moon exactly in front of that of the Sun; the upper and lower ones are the limits of totality: on these lines, the total eclipse lasts just one instant; in other words, the limbs of the Moon and of the Sun will just have an internal contact. Outside this narrow belt, the eclipse will be only partial, the magnitude varying from an inappreciable quantity to practically totality. The area affected by this partial eclipse is immense: Eastern Europe and nearly the whole of Africa and Asia will be visited by a more or less interesting phenomenon, according to the distance from the line of totality.

Near the West Coast of India and near Thibet, small ellipses have been drawn, to show the shape of the shadow on the Earth's surface. It will be seen that the form of the figure has been considerably altered during the passage across India; this is due to the change in the position of the Sun and Moon in the interval. Properly speaking, the shadow is not an ellipse, being the section of a cone on a sphere; but the difference for our purpose is altogether inappreciable. The area of this ellipse at Dumraon (the station chosen by a party of Fathers from St. Xavier's, Calcutta, and St. Joseph's, Darjeeling), at the time of totality, is about 2,250 square miles. When the shadow occupies the position shown by the first ellipse, it is travelling at the rate of 24·5 miles per minute, while the obscuration, at the point occupied by the centre of the figure, lasts 2m. 15s. In Thibet, the other ellipse travels at the rate of 50 miles per minute, the totality being only

1m. 25s. At Dumraon, the velocity of the shadow is 40·2 miles per minute and the total eclipse lasts 1m. 40s.

The transversal lines join the points where the middle of the eclipse occurs at the same moment. These lines are drawn for intervals of 4m., and the instants indicated are given in Greenwich time. St. Xavier's time, which is Gr. T. *plus* 5h. 53m. 26s, is also written near the first line. To obtain Calcutta gun time, subtract 5s. from St. Xavier's time—or, add 5h. 53m. 21s. to Greenwich time.

These transversal lines afford an easy method for determining approximately the greatest phase of the eclipse at any place in India. Take, for instance, Cawnpore. The line closest to this town is that marked 20-16; by drawing through Cawnpore a parallel to the line 20-16, it is immediately seen that the greatest phase will occur there at about 20-17 Greenwich time. If four minutes for each degree of longitude of the place be added to this value, the local time of greatest phase is obtained. The addition of 5h. 21m. to Gr. T. gives Madras or Railway time. As for the magnitude, a comparison of the position of any particular place with those of Bombay, Simla, Calcutta, and Darjeeling will at once, with the help of the diagrams drawn for these towns, give a rough idea of the importance of the phenomenon.

The breadth of the zone of totality may, under the most favourable circumstances, reach 180 miles, but seldom exceeds 140. In the present case, the Moon is in Perigee on the 20th January, but the Earth is in Perihelion on the 22nd January. The conditions being such, the breadth of the zone is only 55 miles when the shadow enters India, 46 miles at Dumraon, and 44 miles when it enters Thibet.

This zone, on the day of the eclipse, will be the scene of unusual astronomical activity. Crowds of astronomers

will point towards the Sun their telescopes, spectroscopes, and cameras, intent on unravelling at least a few of the numerous mysteries in which the study of Solar Physic is still enshrouded. "The following (1) seems to represents the locations of the several parties on the central line. The most western station, Viziadurg, will be occupied by Sir Norman Lockyer with his party, backed up by the officers and crew of one of Her Majesty's ships. Karad, the next station to the east, lying on the Southern Mahratta Railway, will be the place of observation by Professor Michie Smith with his party from the Madras Observatory. Professor Naegamvala, from the College of Science, Poona, with his followers, will also probably adopt this region for work. Further to the east lies Talni, where Mr. Newall, Captain Hills, and a party from the British Astronomical Association will be stationed. Where the central line of totality cuts the road between Nagpur and Seoni, Dr. Copeland will take up his station; while about 150 miles further along the track at Sohagpur, the Astronomer Royal and Professor Turner will be stationed. Still further eastward, at Buxar, on the Ganges, will be located two parties, one consisting of a second section of the British Astronomical Association, and the other the main party of the Great Indian Trigonometrical Survey. (2) It is also likely that the Japanese astronomers will be in this neighbourhood. At Dumraon, still further along the line, the Fathers of the St. Xavier's College, Calcutta, will make observations. Professors Campbell, Schaeberle, Todd, and not improbably M. Deslandres, will be present somewhere on the central line, but the actual positions they will take up are not yet definitely known."

Let us now pass to the diagrams. All the data required for observations accompany these drawings, but many

[1] Nature, December 2, 1897.

[2] According to later information, this party will be stationed at Dumraon.

readers, no doubt, will like to have before them figures rather less microscopical, together with a short explanation of the somewhat mysterious symbols spread over them.

CONTACTS.

	Bombay Cathedral.	Simla Church.	Dumraon.	Calcutta, St. Xavier's.	Darjeeling, St. Joseph's.
	H. M. S.	H. M. S.	H. M. S.	H. M. S.	H. M. S.
1st external contact...	0 14 32	0 42 30	0 49 42	0 56 29	0 59 38
1st internal contact...	.....	.....	2 15 18	.....	.....
Greatest phase ...	1 48 43	2 7 38	totality: 1m. 40s.	2 20 31	2 23 2
2nd internal contact	.....	.....	2 16 58	.....	.....
2nd external contact	3 15 36	3 25 35	3 33 35	3 35 18	3 37 34

Calcutta gun time is used in this table. The times given with the drawings are the local times of the places mentioned.

All the results here given include the seconds ; but it should be kept in mind that these figures are only to be considered as theoretical values, deduced by long calculations from astronomical tables. The science of Astronomy, although already carried to a remarkable perfection, does not yet furnish us with Tables sufficiently accurate to predict eclipses with absolute certainty to the last second —not to speak of decimals.

The points M_1, M_0, M_2, represent the centre of the Moon at the first contact C_1, the greatest phase and the last contact C_2, respectively. In the case of Dumraon, the first internal contact takes place at Γ_1 and the second at Γ_2. The point Σ represents the centre of the Sun.

When the point V_1 is held uppermost, the diagram represents the appearance of the Sun and Moon at the first contact, as seen with the naked eye. If V_1 be held uppermost, we have the telescopic image. This applies also to

V_0 and V_0 for the greatest phase and to V_2 and V_2 for the last contact.

The most important angle for an amateur observer is $V_0 \Sigma C_1$, or the angle between the highest point of the Sun, as seen without a telescope, and the point of first contact. This angle will enable him to keep watch more easily for the beginning of the eclipse, since C_1 is the point of the Sun's circumference where the Moon will first encroach on its surface.

The following table gives $V_0 \Sigma C_1$, together with the magnitude of the eclipse expressed as the part of the Sun's Diameter covered by the Moon at the greatest phase, the least distance ΣM_0 between the centres of the Sun and Moon, the breadth of the crescent at the same instant, and the distance of the different places from the central line :—

OTHER DATA.

	Bombay.	Simla.	Dumraon.	Calcutta.	Darjeeling.
Angle $V_0 \Sigma C_1$ ...	104°0′	131°39′	130°19′	130°58′	135°35′
Magnitude ...	·952	·769	Total	·860	·969
Dist. of centres ...	1′57″	7′51″	1″	4′53″	1′19″
Breadth of crescent	1′34″	7′31″	...	4′33″	1′0″
Dist. from cent. line	140 miles.	559 m.	1·5 m.	332 m.	91 m.

As the Viceroy goes to Buxar to view the eclipse, it may be interesting to add that most of the data given for Dumraon remain very nearly the same for that town. The difference, in fact, between the ocurrence of the contacts at these two places is scarcely worth mentioning, the eclipse reaching Buxar about 15s. only before Dumraon On the other hand, the relative position of the centres of the Sun and of the Moon at Buxar and Dumraon differs. At Dumraon, the Bhojpore Bungalow is below the central

line, and has the centre of the Moon above that of the Sun; at Buxar, above the line, the positions are reversed. This rule is a general one; and, as a consequence, in the case of places having but a partial eclipse, the cusps of the crescent point downwards at any locality, such as Bombay and Simla, north of the zone of totality; upwards, at localities south of it. This is the case for Calcutta and Darjeeling.

The readiness, with which astronomers often submit to great inconvenience to observe solar eclipses, is frequently a puzzle for the public, who seem inclined to question their wisdom in putting themselves to such trouble for apparently such insignificant results. These, however, have considerable scientific and practical value, both in Mathematical and Physical Astronomy. The verification of astronomical tables and of the assumed longitude of the place are among the first. In Physical Astronomy, many and important are the problems requiring solution. The changes and violent convulsions taking place in the Sun, about the causes and true nature of which so little is as yet known to us, are more and more admitted to have a considerable influence on meteorological and other terrestrial phenomena. These are of a nature such as deeply to affect the interests of the human race, and the time of a total solar eclipse is the only one granted to observers for the study of those solar regions, the fainter light of which is habitually drowned in the flood of brightness emitted by our luminary.

Considering the exceedingly short duration of solar eclipses and the means, often very limited, at the disposal of observing parties, it is evident that astronomers remain powerless to tackle simultaneously those numerous problems, and must, on each occasion, strictly limit themselves to a few well-determined points. Those which will specially engross the attention of the Dumraon observers are the photographic reproduction of the Corona and its

adjuncts, and the spectroscopic study of the Corona's light, with special reference to the rays G and H, in the ultra-purple. The point requiring elucidation is whether or not these rays belong to the light of the Corona. Other observations will also be taken, but their number and extent depends much on the amount of local talent the astronomers may be able to secure and inspire with some enthusiasm for the work. They, moreover, hope for the co-operation and help of any reader of these notes who may happen to be favourably situated for observation. No astronomical knowledge nor instruments of any kind are required from would-be helpers, in order that they may become really useful; all that is wanted is the use of their eyes, assisted, may be, though not necessarily, by binoculars. A few words of explanation on the most important usual phenomena will be enough to indicate to them what is specially worthy of their attention.

The beginning and end of a total eclipse do not present any special feature, and do not, in any way, differ from those of an ordinary partial one. The case is different at the time of totality. The interest begins when the centre of the Sun has already been covered. Daylight fades with a rapidity which is almost frightening. The scenery and surrounding objects change colour, and assume a livid, almost cadaverous look, and the horizon a dull yellowish tint. The intensity of the darkness depends much, however, on the state of the sky, and the effect is much increased by the rapidity of the change. It is much more striking when the sky is quite clear. In reality, the luminous intensity is more or less equal to that of the Full Moon. Stars of the first and second magnitudes become visible, and even sometimes those of the third and fourth. It is, at the time, generally possible to read large print, but not small characters, for instance, the graduations of instruments.

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As the time of totality approaches, colours are still more deeply modified. The phenomenon may be observed in all its intensity, if use is made of juxtaposed bands of paper or stuff having more or less the colours of the rainbow. The most refrangible of them, purple, indigo, etc., all but disappear, while the others pale. This is due to the smoky yellowish light of the Sun's border.

Together with light, temperature falls briskly. To this are often due mist and clouds interfering seriously with observations. Halos, more or less bright and complete, are formed at times, and clouds in the neighbourhood of the Sun frequently show irradiation.

The disappearance and reappearance of the Sun are generally accompanied by luminous fringes and oscillating shadows which travel across the horizon. They are best observed by projection on a large white sheet spread on the ground. Their breadth and number vary very much. As many as 17 have been counted, and some have been seen more than three inches broad. Their colouring varies also. At times, they are only alternating bands of light and shadow, somewhat similar to those projected on the opposite wall by a light carried in front of a close grating, but more frequently they exhibit different tints. The fringes observed in 1869 were among the most remarkable, and consisted of bands of pink, purple, yellow, orange, and fiery red; no green, nor blue was seen, with the exception of a bluish tinge in the purple. They were all separated by dark stripes. These fringes have a very rapid oscillation, and accompany the Moon's Umbra, on the border of which they are particularly noticeable. Their inclination varies in such a way that they are ultimately tangent to the solar disc at the point last disappearing. Though it be possible to observe the phenomenon through the whole zone of totality, it is seen to greater advantage in localities close to or even a little outside its limits.

Another striking spectacle, perceptible at about the same time, is the rapid and visible advance of the Moon's shadow over the surrounding country. It looks like that of a huge elliptic or rather very slightly ovoid cloud proceeding at a giddy speed. The effect is more strongly marked, when the sky is somewhat hazy.

But the glory of a solar eclipse resides in the Aureola, some of the brightest parts of which may often be perceived even before totality and a little after. As the solar orb slowly vanishes and darkness increases, a death-like and universal silence spreads over nature. Most animals seem struck with fear, others prepare for their night's rest. Man himself is not indifferent to these impressions. But soon the threadlike solar crescent, breaking into bead-shaped granulations, finally disappears. Then, as under the stroke of a magic wand, a wonderful spectacle strikes the observer's eye. From the disc of the Moon, dark and inky on a leaden sky, long luminous streamers suddenly dart through space; rays more or less undulating and of varied brightness surround the disc, while, in immediate contact with it, is a brighter but narrower zone interspersed with rosy flames, clouds and vapours. This constitutes the Aureola, the splendour and details of which differ in various eclipses, but to the magnificence of which no human art can do justice. As its luminous intensity varies rapidly, it is difficult to determine it with exactitude, but its lighting power is not inferior to that of the Full Moon at the zenith during a clear night. Much, however, depends on the state of the atmosphere.

These three zones are distinct but not sharply separated. The outer one is, as we have seen, that of the streamers. These are bunches of bright diverging rays, straight, and of varied breadth often slightly coloured, habitually a faint mauve or purple-blue, and stretching at times as far as several lunar diameters. Their shape and length vary much

even during the same eclipse, and again in their case, much depends on the state of the sky. With the exception of these variations in length and luminous intensity, and sometimes a slow though perceptible shifting of position round the disc, the streamers are motionless, and greatly resemble the luminous streaks seen through cloud openings at sunset. Rays have also now and then, but seldom, been observed, of a special brilliancy, and not radiating as the others. They have generally been seen as if issuing from a spot noticeable by a particularly bright prominence. Some observers have advanced, as a possible explanation of those exceptional rays, the transit of a cometary mass through the solar atmosphere. Attempts to photograph the streamers do not seem up to this to have been successful. Their faint light is likely enough not sufficiently actinic for the purpose. The pencil is the only help the observer has at his disposal for recording their shape and position.

The rest of the Aureola receives the name of Corona; it consists of two parts—the outer and the inner one. The outer Corona has often a breadth equal to a lunar diameter, but in it the luminous gradation is very rapid, and its borders melt away into the dark background. Too weak to stand the dispersing power of large instruments, it is seen to greater advantage by the naked eye, or at most by the help of ordinary binoculars. It consists of luminous rays of varying brilliancy; now straight and diverging, then entwined, or curved towards one another, assuming petal-like shapes, to which the name of Dahlia leaves has been given. Others, branching off, are called Stag-horns: others again are arched over, forming kinds of bridges. Among them appear at times, as light clouds, small less luminous masses. The Corona or crown formed by these rays is not everywhere of the same breadth, but it is commonly more extended at about 45° from the solar Poles, and is also often more marked at the solar Equator. At the Poles,

and sometimes at other places, are frequently seen dark spaces from which the rays curve off, as if under the influence of repulsion. These spaces receive the name of Rifts, and now and then almost reach to the lunar disc. Their study is of some importance, and the attention of observers is called to them.

Nearer the Moon than the region we have been speaking of, is a much brighter circle, 3′ or 4′ in breadth, and already partly visible a little before absolute totality. It is of a dazzling white, and in it are to be seen the rosy flames and clouds called prominences. It is at least as bright as the Full Moon, and is photographed without any more difficulty than the Moon itself. The rosy appearances in it are of two kinds: thin arcs, some 15″ or 30″ thick and extending sometimes as far as 30° in length, and ruddy luminous masses rising from them as well as from other points of the solar disc, called prominences. They are of the most varied and irregular forms. Some are like gigantic flames bent down and distorted by a hurricane, or float in the solar atmosphere like fiery clouds; some form bridge-like structures or gothic arches, or again rise straight through space as the luminous jet of a huge explosion. Those prominences are generally attributed to violent eruptions at the surface of the Sun, and the height of some of them has been estimated at over thirty thousand miles. On account of their bright colour and elevation, they are often visible, a little before and after totality, on the side of the Moon opposite to the still visible solar crescent.

Such is the solar Aureola, of which but a faint idea can be given in words. Our intention in rapidly sketching its main features, together with those of the other concomitant phenomena of a solar eclipse, was not to endeavour to do it justice—that would be a useless attempt—but simply to indicate to those who may have the good fortune of

observing any of them, what they may expect to see, and to what special points their attention ought to be chiefly directed.

Were any one of our readers to obligingly consent to give us the most welcome assistance of his personal local observations, any communication from him would be gratefully received by the Rev. C. de Clippeleir, S.J., Director of the St. Xavier's Observatory, 10, Park Street, Calcutta. The results obtained, as soon as they are ready for publication, will gladly be forwarded to any such helper if he kindly adds to his note his full name and address. Many things necessarily escape the professional observer in a solar eclipse, absorbed as he is in the manipulation of his instruments, or the investigation of the leading phenomena, for the study of which his time is so exceedingly limited; and facts observed by others often come handy to him as completing or confirming the results he has obtained. No detail is unworthy of notice, and notes on the changes of appearance and colour of various objects, of the sky, of clouds, water, land, the general scenery, on the visible stars and planets,[1] on the fall of temperature and luminous intensity, or on any other phenomenon, however indirectly connected with the eclipse, may all have their importance. For observations more closely referring to the eclipse itself, the following queries, compiled by Sir Norman Lockyer,[2] will sufficiently indicate to willing

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[1] On the 22nd January, the Right Ascension of the Sun and Moon, at the time of their conjunction, is 20h. 19m.; the Declination of the Sun is 19°6′S. and that of the Moon 19°36′ S. Mercury, Venus, and Mars are the only planets which may perhaps be seen during the eclipse; as may be seen from the following data, they are all to the west of the Sun. Their approximate position and apparent diameter will be :—

Mercury,	R. A. 18h. 38m.;	Decl. 20° 58′ S.;	App. Diam.	7 6″
Venus,	,, 19h. 54m.;	,, 21° 39′ S.;	,,	10·0″
Mars,	,, 19h. 6m.;	,, 23° 23′ S.;	,,	4·0″

[2] Recent and coming Eclipses, by Sir Norman Lockyer, 1897, p. 13.

observers the points more particularly worthy of their attention :—

(*a*) Has there been any change in the appearance of the Corona during the eclipse? If so, specify that change.

(*b*) Have especially the dark rays or rifts changed during the eclipse?

(*c*) Describe what has been unchanged throughout, and define its structure.

(*d*) State the colours you observed outside the red prominences.

(*e*) Were the colours anywhere arranged in layers round the Sun?

(*f*) Were the colours anywhere arranged radially?

(*g*) State the colour of the rays, and of the spaces between them.

(*h*) Did the dark rifts extend to the Moon, or did they stop short over the bright denser layers of the chromosphere?

(*i*) Were the rays brighter near the Moon, or far away from it?

(*j*) What was the comparative brightness of the rays, the bright ring near the Sun, and the outer Corona?

Groups of intending contributors, who would generously undertake this useful work, would find not only their efficiency greatly increased, but also matters notably simplified for them, were they to distribute among themselves the task of answering these different questions. By following this plan, they would have their attention less divided, and their more complete and thorough personal observations of each individual phenomenon might, as part of a whole, become more truly useful and acquire greater scientific value.

V. DE CAMPIGNEULLES, S.J.
H. JOSSON, S.J.

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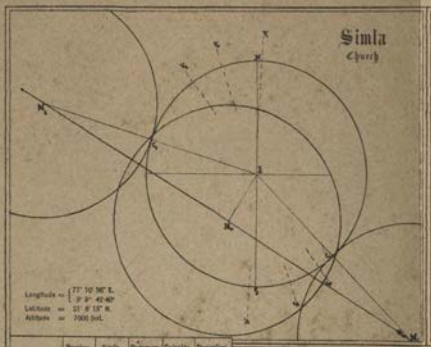
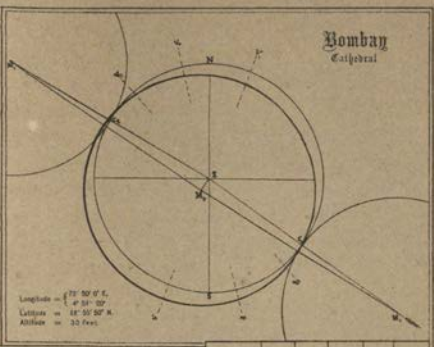
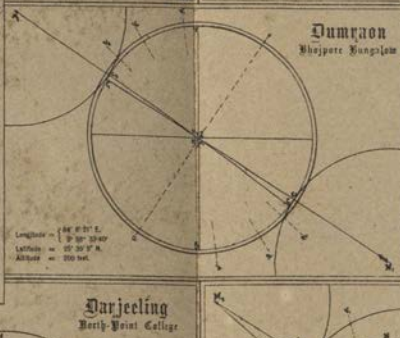
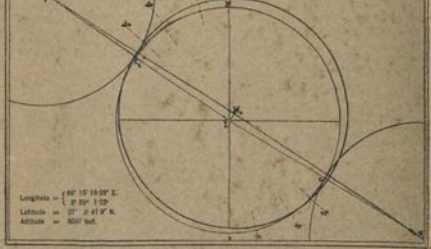
SOLAR ECLIPSE

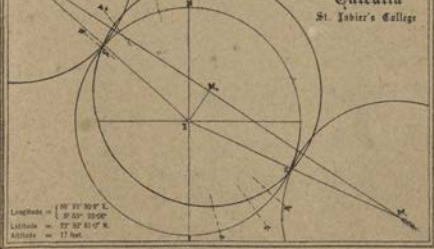
22ND OF JANUARY, 1898.











	Bombay.	Simla.	Dumraon.	Calcutta.	Darjeeling.
Lunar Pol. M.	16° 29·03"	16° 35·76"	16° 35·91"	16° 37·9"	16° 36·3"
" " N.	16° 27·46"	16° 34·72"	16° 35·01"	16° 34·9"	16° 35·0"
" " M.	16° 28·25"	16° 35·24"	16° 35·46"	16° 36·4"	16° 35·6"

Solar Radius = 16° 14·83".

Solar Vertex at M., M., M.: Phases, Direct Image: V., V., V.

" " " " " Telescopic Image: v., v., v.

Solar Centre: ⊙.

Lunar Centre: M., M., M., m., m.

Points of Contact: C., C., External: c., c., Internal.

Total Eclipse.

Distance between Limbs of Sun and Moon: Least ... at Q = 19·18".

" " " " " Greatest at P = 21·01".

" " " " " Mean = 20·18".

Projection of Cone's Section: Semi Minor Axis = 22 Miles.

" " " Semi Major Axis = 39½ " N. 23° E.

" " " Area = 2294 Square Miles.

Breadth of Zone of Totality = 46 Miles.

Velocity of Cone of Shadow = 42·2 Miles per Minute N.A.B.½ E.

Inclination of Cone's Axis with Earth's Surface: Long. E. = 84° 7·9'

" " " " Lat. N. = 20° 58·6'

	Bombay.	Simla.	Dumraon.	Calcutta.	Darjeeling.
1st Exter Contact	1° 12' 31"	1° 11' 50"	0° 52' 58"	0° 50' 34"	0° 50' 16"
" Intern. "	—	—	1° 58' 39"	—	—
Greatest Phase	0° 46' 47"	1° 0' 9"	1° 58' 39"	1° 0' 28"	2° 0' 47·9"
2nd Intern. Cont.	—	—	2° 0' 19"	—	—
" Exter. "	2° 13' 49"	2° 9' 58"	3° 10' 44"	2° 10' 22"	3° 11' 19"
Angle N.M.	154° 43'	136° 1'	123° 7'	115° 15'	120° 56'
" N.C.	—	—	66° 16'	—	—
" N.M.	146° 21'	147° 32'	56° 18'	64° 4'	33° 23'
" N.C.	—	—	106° 35½'	—	—
" N.M.	38° 56'	71° 13½'	96° 50½'	48° 1'	54° 56'
" N.V.	20° 42'	9° 22'	7° 12'	15° 23'	14° 39'
" N.V.	12° 56'	18° 47'	30° 50'	38° 9'	35° 6'
" N.V.	28° 6½	28° 25½	46° 8½'	51° 47'	48° 6'
Distance cM.	1° 57·15"	2° 51·07"	1·08"	4° 59·0"	1° 19·96"
" cM.	—	—	29·21"	—	—
" CM.	—	—	29·15"	—	—
Magnitude	·932	·769	Total	·989	·989
Breadth of Crescent	1° 34·13"	1° 51·13"	1° 1·40"	4° 32·9"	29·54"
Dist. from Cent. Line	140 miles	520 m.	1½ m.	380 m.	81 m.

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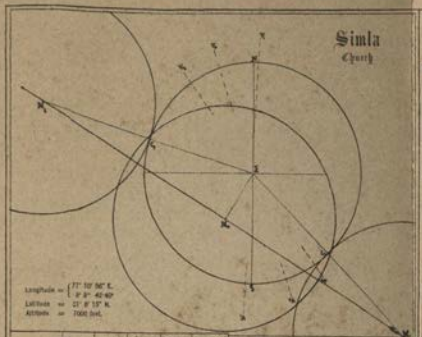
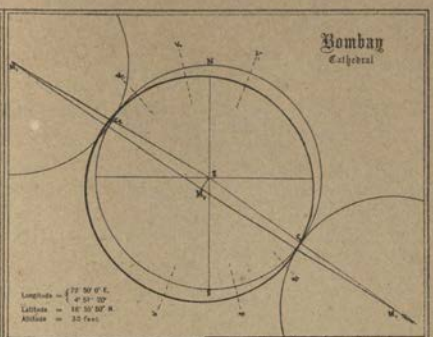
H. Jansen, S.J.

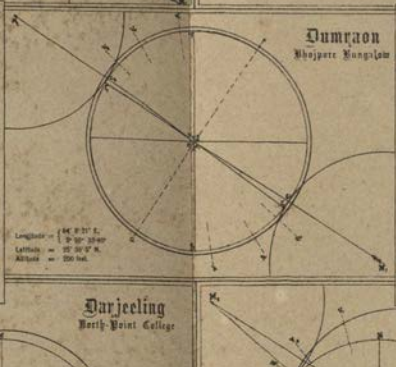
Photo., S. J. O., Calcutta.

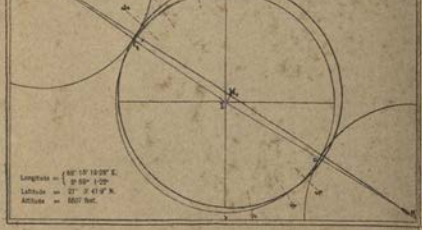
SOLAR ECLIPSE

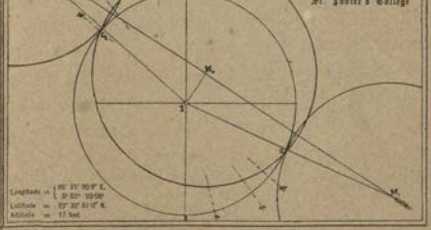
22ND OF JANUARY, 1898.











	Bombay.	Simla.	Dumraon.	Calcutta.	Darjeeling.
Lunar Perl. M.	16° 28' 03"	16° 26' 36"	16° 30' 01"	16° 31' 0"	16° 36' 3"
" " M.	16° 31' 06"	16° 34' 27"	16° 30' 28"	16° 28' 9"	16° 24' 0"
" " M.	16° 29' 51"	16° 30' 48"	16° 31' 19"	16° 32' 4"	16° 30' 6"

Solar Radius = 16° 14' 57".

Solar Vertex at M., M., M., Phases, Direct Image. V., V., V.,

" " " " Telescopic image. v., v., v.

Solar Centre: S.

Lunar Centre: M., M., M., m., m.

Points of Contact: E., E., External: I., I., Internal.

Total Eclipse.

Distance between Limbs of Sun and Moon: Least at Q = 19' 13".

" " " " : Greatest at P = 21' 21".

" " " " : Mean = 20' 18".

Projection of Conic's Section: Semi Minor Axis = 25 Miles.

" " " Semi Major Axis = 53 " N. 25° E.

" " " Area = 2254 Square Miles.

Breadth of Zone of Totality = 46 Miles.

Velocity of Cone of Shadow = 40·2 Miles per Minute N. 4·8 E.

Intersection of Conic's Axis with Earth's Surface: Long. E. = 84° 7·9

" " " " : Lat. N. = 25° 59·4

	Bombay.	Simla.	Dumraon.	Calcutta.	Darjeeling.
1st Exter. Contact	11° 19' 21"	11° 17' 20"	0° 22' 55"	0° 24' 24"	0° 28' 16"
" Intern. "	—	—	1° 56' 30"	—	—
Greatest Phase	0° 49' 43"	1° 23' 0"	1° 24' 20"	1° 23' 34"	1° 21' 43·5"
Ext Intern. Cont.	—	—	2° 0' 10"	—	—
" Exter. "	2° 13' 49"	2° 49' 55"	2° 10' 44"	2° 22' 57"	2° 15' 11"
Angle N.M.	104° 42'	136° 1'	123 7'	115° 23'	120° 56'
" N.M.	—	—	88° 16'	—	—
" N.M.	146° 21'	147° 32'	38° 18'	84° 4'	33° 23'
" N.M.	—	—	126° 33½'	—	—
" N.M.	56° 55'	71° 13½'	66° 39½'	48° 1'	54° 56'
" N.M.	20° 42'	8° 22'	7° 12'	15° 23'	14° 30'
" N.M.	12° 58'	16° 47'	30° 55'	26° 5'	25° 8'
" N.M.	28° 6½'	35° 25½'	46° 8½'	61° 47'	48° 8'
Distance M.	1° 57·15'	2° 51·01'	1·08'	0° 23·0'	1° 19·06'
" M.	—	—	29·21'	—	—
" M.	—	—	29·16'	—	—
Magnitude	·902	·780	Total	·909	·969
Breadth of Cresent	1° 54·12'	2° 21·12'	Least 1° 40'	4° 32·9'	59·04'
Dist. from Cent. Line	140 miles	539 m.	11 m.	332 m.	91 m.

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H. Jouvet, S.J.

Photo., S. J. C., Calcutta.

SOLAR ECLIPSE, 22nd OF JANUARY 1898.

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